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Attorney's Docket No. 2576-118

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. Application No. (if known, see 37 CFR 1.5) Not Yet Assigned 09/936294

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/00103	January 12, 2000	

TITLE OF INVENTION
MOBILE COMMUNICATION TERMINAL AND METHOD OF COMMUNICATION

APPLICANT(S) FOR DO/EO/US
Yuji KAKEHI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

   [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. [X] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

ITEMS 11. TO 16. below concern other document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A **FIRST** preliminary amendment.
    [ ] A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. [X] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information: Courtesy copy of International Application PCT/JP00/00102 w/attached International Search Report in Japanese and English; 9 sheets of drawings; 13 cited references, Form PCT/IB/301 and Form PCT/IB/308.

JC03 Rec'd PCT/PTO 12 SEP 2001

U.S. APPLICATION NO. (If known, see 37 CFR 1.50) 09/936294 Not Yet Assigned	INTERNATIONAL APPLICATION NO. PCT/JP00/00103	ATTORNEY DOCKET NO. 2576-118

	CALCULATIONS	PTO USE ONLY
17. [X] The following fees are submitted: **Basic National Fee (37 CFR 1.492)(a)(1)-(5):** Search Report has been prepared by the EPO or JPO $ 860.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) $ 690.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $ 710.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $ 1,000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $ 100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	18 -20 =	0	X $18.00	$	
Independent Claims	4 - 3 =	1	X $80.00	$ 80.00	
Multiple dependent claim(s) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 940.00	
Reduction by 1/2 for filing by small entity, if applicable. Applicant(s) hereby claim small entity.				$	
SUBTOTAL =				$ 940.00	
Processing fee of $130.00 for furnishing the English translation later [ ] 20 [ ] 30 than months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 940.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$ 940.00	
				Amount to be refunded	$
				charged	$

a. [X] A check for $ 940.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. 02-2135 in the amount of $________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-2135. A duplicate copy of this sheet is enclosed.

d. [ ] Payment by credit card. (Form PTO-2038 enclosed.)

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE	*Application Number*	§371 of PCT/JP00/00103
	Filing Date	September 12, 2001
	First Named Inventor	Yuji KAKEHI
	Group Art Unit	Unassigned
	Examiner Name	Unassigned
	Attorney Docket Number	2576-118

Title of the Invention: Mobile Communication Terminal and Method of Communication

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Please amend the above-identified U.S. patent application as follows:

IN THE SPECIFICATION:

Please amend the specification as shown in the attached copy labelled "Marked-up copy of Amended Specification". A clean copy of the specification is provided as Tab 14.

IN THE CLAIMS:

Please amend claims 1-17 as follows. A marked-up copy of the amended claims is attached.

Clean copy of Amended Claims:

1. (Amended) A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2);

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid cell.

2. (Amended) The mobile communication terminal according to claim 1, wherein said control unit (4) determines the invalid cell based on information received from the base station, and stops the processing of said cell.

3. (Amended) The mobile communication terminal according to claim 2, wherein said detector (5, 6, 7) includes:

a slot timing detector (5) detecting slot timing from the signals received by said receiver (2),

a code group detector (6) detecting a code group based on the slot timing detected by said slot timing detector (5) from the signals received by said receiver (2), and

a code detector (7) detecting a code based on the slot timing detected by said slot timing detector (5) and the code group detected by said code group detector from the signals received by said receiver (2).

4. (Amended) The mobile communication terminal according to claim 3, wherein said control unit (4) stops the processing of received signals when the code group detected by said code group detector (6) is not a predetermined code.

5. (Amended) The mobile communication terminal according to claim 4, wherein said code group detector (6) includes:

a plurality of code generators (15-1 - 15-N), each of said code generators (15-1 - 15-M) generating a code corresponding to a different code group,

a dummy code generator (15-(M+1) - 15-N) generating a dummy code different from the code groups generated by said plurality of code generators (15-1 - 15-M),

a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 - 16-N) calculating correlation between the signal received by said receiver (2) and the code generated by the corresponding code generator (15-1 - 15-N), and

a determining unit (18) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (16-1 - 16-N).

6. (Amended) The mobile communication terminal according to claim 3, wherein said control unit (4) stops the signal processing of the cell search if the code detector (7) detects a code group other than a code group including the predetermined code.

7. (Amended) The mobile communication terminal according to claim 6, wherein said code detector (7) includes:

a plurality of code generators (19-1 - 19-N), each of said code generators (19-1 - 19-M) generating a different code,

a dummy code generator (19-(M+1) - 19-N) generating a dummy code different from the codes generated by said plurality of code generators (19-1 - 19-M),

a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N), and

a determining unit (22) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. (Amended) A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) dividing a slot into a plurality of search ranges, deleting multipath in said search range, successively allowing said demodulator (8) to demodulate the received signals and allowing said decoder (9) to decode the demodulated data.

9. (Amended) The mobile communication terminal according to claim 8, wherein said control unit (4) stops the decode processing if the decoded data in said search range is invalid data.

10. (Amended) A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
demodulating the received signals with said detected spread codes;
decoding said demodulated data; and
controlling cell search process, and stopping signal processing of the cell search if said demodulated data is invalid cell.

11. (Amended) The communication method according to claim 10, wherein said step of stopping the signal processing of the cell search includes the step of determining invalid cell based on information received from the base station, and stopping the signal processing of the cell search.

12. (Amended) The communication method according to claim 11, wherein said step of detecting the spread codes includes the steps of:
detecting slot timing from said received signals,
detecting a code group based on said detected slot timing from said received signals, and
detecting a code based on said detected slot timing and said detected code group.

13. (Amended) The communication method according to claim 12, wherein said step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code group received from the base station is not a code group including a predetermined code.

14. (Amended) The communication method according to claim 13, wherein said step of stopping the signal processing of the cell search includes the steps of:

generating codes corresponding to a plurality of different code groups,

generating a dummy code different from said plurality of generated code groups,

calculating correlations of said received signals with respect to said plurality of generated code and the dummy code, and

determining invalidity of the detected code group based on a result of said calculation.

15. (Amended) The communication method according to claim 12, wherein said step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code received from the base station is not a predetermined code.

16. (Amended) The communication method according to claim 15, wherein said step of stopping the signal processing of the cell search includes the steps of:

generating a plurality of different codes,

generating a dummy code different from said generated code,

calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and

determining invalidity of the data based on a result of said calculation.

17. (Amended) A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

deleting multipath of the code already detected;

successively demodulating the received signals subjected to the deletion of the multipath with said detected spread codes; and

decoding said demodulated data.

REMARKS

The above amendments are being made to make amendments to the sepcification and claims prior to examination on the merits. The amendments do not add to or depart from the original disclosure, or constitute prohibited new matter.

RESPECTFULLY SUBMITTED,					
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Attachments: Marked-Up Copies of Amendments

SUBSTITUTE SPECIFICATION

Mobile Communication Terminal and Communication Method

Technical Field

[0001] The present invention relates to a mobile communication terminal employing a code division multiplex method for communication, and particularly a mobile communication terminal which rapidly searches adjacent cells during cell search.

Background Art

[0002] In recent years, mobile communication terminals such as a portable telephone and a mobile telephone have been widely used, and various kinds of multiple access methods have been developed for use in such mobile communication systems. Among them, a CDMA (Code Division Multiple Access) method has been employed in portable telephones and others because it has high quality reception capability through the exploitation of multipath fading, and can achieve a high utilization efficiency of radio resource (can increase a subscriber capacity).

[0003] Fig. 8 is a schema which shows that the mobile station can receive a number of radio waves transmitted from adjacent cells via multiple propagation paths (multipath). In general, a plurality of base stations (BS1 - BS5) are arranged regularly, and cells of the base stations form a regular polygon if these base stations are arranged to cover a service area with as high a electric field as possible, as is well known and shown in Fig. 8. When a mobile communication terminal (MS) performs the cell search, it receives a plurality of radio waves from respective base stations, and additionally receives radio waves (multipath), which are transmitted from various base stations, and are shifted in timing from each other due to wave reflection and diffraction. This multipath is not necessary, and therefore is deleted during the cell search operation by an appropriate manner.

[0004] A stepwise search method has been known as a fast cell search method. Fig. 9 shows a processing procedure for detecting and deleting multipath components in the stepwise search method. First, slot timing for those including multipath components is detected (short-period detection) (S101). Detection of slots is performed by detecting search codes of the slots. By detecting the frame timing code, the frame timing is detected (long-period detection), and further the code group is detected (S102).

[0005] In addition to the code group, the candidate codes which belong to the group is further evaluated (S103), and finally a spread codes is identified. Information such as spread codes, which is required for recognizing the multipath, is stored in a memory 110 (S104). In this manner, the multipath is recognized based on the information of code and timing stored in memory 110, and the multipath is deleted from the obtained information (S105). The information, from which the multipath is deleted as described above, is decoded so that an amount of decode processing is reduced, and fast cell search can be achieved.

[0006] However, the multipath is deleted after all the slot timing, frame timing and codes for one slot are detected and stored in memory 110. This results in a problem that the time required for the entire cell search cannot be reduced.

[0007] The invention has been developed for overcoming the above problem, and a first object of the invention is to provide a mobile communication terminal allowing fast cell search.

[0008] A second object of the invention is to provide a mobile communication terminal allowing accurate identification of spread codes.

[0009] A third object of the invention is to provide a communication method allowing fast cell search.

[00010] A fourth object of the invention is to provide a communication method allowing precise identification of spread codes.

Disclosure of the Invention

[00011] According to an aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver; a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid cell.

[00012] The control unit stops the signal processing of the cell search when invalid cell is received. Therefore, the cell search can be performed fast.

[00013] Preferably, the control unit determines the invalid cell based on the information received from the base station, and stops the processing of the cell.

[00014] Since the control unit stops the processing of the cell based on the information received from the base station, the cell search can be performed fast even in the cases, e.g., of erroneous detection of an unexisting code or frame timing.

[00015] The detector includes a slot timing detector detecting slot timing from the signals received by the receiver, a code group detector detecting a code group based on the slot timing detected by the slot timing detector from the signals received by the receiver, and a code detector detecting a code based on the slot timing detected by the slot timing detector and the code group detected by the code group detector from the signals received by the receiver.

[00016] The code group detector and the code detector detect the code group and the code based on the slot timing detected by the slot timing detector, respectively. Therefore, the identification of the spread codes of each slot can be accurately performed.

[00017] More preferably, the control portion stops the processing of received data when the code group detected by the code group detector is not a predetermined code.

[00018] Since the control unit stops the processing of received signals in the case where the code group detected by the code group detector is not the predetermined code, the cell search processing can be performed fast even in the case where an unexisting code group is erroneously detected.

[00019] More preferably, the code group detector includes a plurality of code generators generating a code corresponding to a different code group, a dummy code generator generating a dummy code different from the code group generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators and a determining unit determining invalidity of the detected slot timing based on the calculation result of the plurality of correlators.

[00020] Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, it is possible to detect an inappropriate code group.

[00021] More preferably, the control unit stops the signal processing of the cell search if the code detector detects the code group other than the code group including the predetermined code.

[00022] Since the control unit stops the signal processing of the cell search if the code detector detects the code other than the predetermined code, the processing of cell search can be performed fast even if an unexisting code is erroneously detected.

[00023] More preferably, the code detector includes a plurality of code generators generating different codes, respectively, a dummy code generator generating a dummy code different from the codes generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the

receiver and the codes generated by the plurality of code generators, and a determining unit determining invalidity of the detected slot timing based on the calculation result of the plurality of correlators.

[00024] Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, an inappropriate code can be detected.

[00025] According to another aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver, a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit dividing a slot into a plurality of search ranges, deleting multipath in the search range, successively allowing the demodulator to demodulate the received signals and allowing the decoder to decode the demodulated data.

[00026] The control unit divides the slot into a plurality of search ranges, deletes the multipath in the search range, and allows the decoder to decode successively the received data. Therefore, the data processing by the decoder can be reduced, and the cell search processing can be performed fast. Further, the detector, demodulator, decoder and control portion can be operated in parallel to perform pipeline processing so that the processing speed can be further increased.

[00027] Preferably, the control unit stops the decode processing if the decoded data in the search range is invalid data.

[00028] Since the control portion stops the decode processing if the decoded data in the search range is invalid data, the time required for the cell search can be further reduced.

[00029] According to further another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; demodulating the received signals with the detected spread codes; decoding the demodulated data; and controlling a cell search process, and stopping the signal processing of the cell search if the demodulated data is invalid.

[00030] If the demodulated data is invalid, the signal processing of the cell search is stopped so that the cell search can be performed fast.

[00031] Preferably, the step of stopping the signal processing of the cell search includes the step of determining invalid cell based on the information received from the base station, and stopping the signal processing of the cell search.

[00032] Since the signal processing of the cell search is stopped based on the information received from the base station, the cell search can be performed fast, for example, even in the case where an unexisting code is detected.

[00033] More preferably, the step of detecting the spread codes includes the steps of detecting slot timing from the received signals, detecting a code group based on the detected slot timing from the received signals, and detecting a code based on the detected slot timing and the detected code group.

[00034] Since the code group and the code are detected based on the detected slot timing, the spread codes of each slot can be accurately identified.

[00035] More preferably, the step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code group received from the base station is not a code group including a predetermined code.

[00036] Since the signal processing of the cell search is stopped if the code group is not the code group including the predetermined code, the processing of cell search can be performed further fast if inappropriate data is received from the base station.

[00037] More preferably, the step of stopping the signal processing of the cell search includes the steps of generating codes corresponding to a plurality of different code groups, respectively, generating a dummy code different from the plurality of generated code groups, calculating the correlation of the received data with respect to the plurality of generated code and the dummy code, and determining invalidity of the detected code group based on a result of the calculation.

[00038] Since the correlation between the received data and the generated code is calculated, an inappropriate code group can be detected.

[00039] More preferably, the step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code received from the base station is not a predetermined code.

[00040] If the code is different from the predetermined code, the signal processing of the cell search is stopped so that the cell search processing can be performed further fast even if an unexisting code group is erroneously detected.

[00041] More preferably, the step of stopping the signal processing of the cell search includes the steps of generating a plurality of different codes, generating a dummy code different from the generated code, calculating a correlation of the received data with respect to the plurality of generated codes and the dummy code, and determining invalidity of the data based on a result of the calculation.

[00042] Since the correlation between the received data and the generated code is calculated, an inappropriate code can be detected.

[00043] According to still another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; deleting multipath of the code already detected; successively demodulating the received signals subjected to the deletion of the multipath with the detected spread codes; and decoding the demodulated data.

[00044] The multipath of the code already detected is deleted, and the received data is successively demodulated and decoded. Therefore, the decode processing can be eliminated, and the processing of cell search can be performed fast.

[00045] Preferably, the decoding processing is not performed in the step of deleting the multipath if the newly detected code is the multipath.

[00046] Since the decode processing is not performed if the newly detected code is the multipath, the time required for the cell search can be further reduced.

Brief Description of the Drawings

[00047] Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention;

Fig. 2 is a block diagram showing schematic structures of a frame timing and code group detector 6 and a code detector 7 of the mobile communication terminal of the first embodiment of the invention;

Fig. 3 is a flowchart for showing a processing procedure of the mobile communication terminal of the first embodiment of the invention;

Fig. 4 is a block diagram showing a schematic structure of a frame timing and code group detector 6' of a mobile communication terminal of a second embodiment of the invention;

Fig. 5 is a block diagram showing a schematic structure of a code detector 7' of the mobile communication terminal of the second embodiment of the invention;

Fig. 6 is a flowchart showing a processing procedure of a mobile communication terminal of a third embodiment of the invention;

Fig. 7 shows determination of a multipath component;

Fig. 8 shows that MS receives radio waves which include multipath components from adjacent cells;

Fig. 9 is a flowchart showing recognisition and deletion of the multipath component during cell search in the prior art.

Best Mode for Carrying Out the Invention

[00048] The invention will now be described in greater detail with reference to the drawings.

(First Embodiment)

[00049] Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention. This mobile communication terminal includes an antenna 1, a receiver 2 which receives a weak radio frequency wave sent from base stations via antenna 1 and down-converts that into a baseband frequency wave, an A/D (Analog-to-Digital) converter 3 which converts received analog signals into digital signals, a microcomputer 4 which performs entire control of the mobile communication terminal, a slot timing detector 5 for detecting slot timing during cell search, a frame timing and code group detector 6 which detects frame timing and code group during cell search, a code detector 7 which detects a code during cell search, a demodulator 8 which demodulates a received code with a detected spread codes, a decoder 9 which decodes the received signals demodulated by demodulator 8, and a memory 10 which stores a program to be executed by microcomputer 4 and others. The detection of the frame timing may be performed by code detector 7.

[00050] Fig. 2 is a block diagram showing a schematic structure of frame timing and code group detector 6. Frame timing and code group detector 6 includes code generators 1 - N (11-1 - 11-N) generating codes, which are used when detecting a code group, correlators 1 - N (12-1 - 12-N) which calculates correlations between a digital signal sent from A/D converter 3 and the codes generated by code generators 1 - N (11-1 - 11-N), a comparator 13 comparing correlation values output from correlators 1 - N (12-1 - 12-N), and a determining unit 14 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 13. The result of determination of determining unit 14 is stored in memory 10.

[00051] Code detector 7 has a structure similar to that of frame timing and code group detector 6 shown in Fig. 2. However, code generators 1 - N (11-1 - 11-N) do not generate the codes for detecting the code group, but generate the codes for detecting the codes so that correlators 1 - N (12-1 - 12-N) calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (11-1 - 11-N).

[00052] Fig. 3 is a flowchart showing a processing procedure of the mobile communication terminal of the first embodiment of the invention. First, slot timing detector 5 receives the digital signal sent from A/D converter 3, and detects the slot timing (S1). Frame timing and code group detector 7 detects the frame timing from the

digital signal sent from A/D converter 3 using the frame timing code, and detects the code group based on the slot timing detected by slot timing detector 5 (S2).

[00053] Then, microcomputer 4 determines whether the frame timing and code group detected by frame timing and code group detector 6 are valid or not (S3). For example, it is determined that the code group is invalid if there is no code group exhibiting a high correlation, as will be described later in connection with a second embodiment. If it is determined that the frame timing or code group is invalid (invalid in S3), microcomputer 4 ends the processing as it is. If it is determined that the frame timing and code group are valid (valid in S3), microcomputer 4 operates to detect the code by code detector 7 (S4).

[00054] Then, microcomputer 4 determines whether the code detected by code detector 7 is valid or not (S5). For example, it is determined that the code is invalid if the code exhibiting a high correlations is not present, as will be described later in connection with the second embodiment. When it is determined that the code is invalid (invalid in S4), microcomputer 4 stops the processing as it is. When it is determined that the code is valid (valid in S4), microcomputer 4 stores the code in memory 10. The multipath is detected and deleted from the code stored in memory 10 (S7). Decoder 9 decodes the data demodulated by demodulator 8 to acquire the notification information, and the processing ends.

[00055] According to the mobile communication terminal of this embodiment, as described above, the information is not stored, and the processing stops if the frame timing, code group or code is invalid. Therefore, the detection of the multipath during the cell search can be efficiently performed, and the processing speed can be improved.

(Second Embodiment)

[00056] A mobile communication terminal of a second embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the structures of the frame timing and code group detector and the code detector as well as the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated. In the second embodiment, the frame timing and code group detector and the code detector bear the reference numbers 6' and 7', respectively.

[00057] Fig. 4 is a block diagram showing a schematic structure of frame timing and code group detector 6' of the second embodiment. Frame timing and code group detector 6' includes code generators 1 - M (15-1 - 15-M) generating codes for detecting the frame timing and the code group, code generators M+1 - N (15-(M+1) - 15-N) generating dummy codes, correlators 1 - N (16-1 - 16-N) which calculate correlations between the digital signals sent from A/D converter 3 and the codes output from code

generators 1 - N (15-1 - 15-N), a comparator 17 which compares correlation values output from correlators 1 - N (16-1 - 16-N), and a determining unit 18 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 17.

[00058] Code generators 1 - M (15-1 - 15-M) generate codes for detecting the original frame timing code and code group. Meanwhile code generators M+1 - N (15-(M+1) - 15-N) are employed for generating codes for detecting the frame timing code and dummy code group, and thus generate the dummy codes different from the codes generated by code generators 1 - M (15-1 - 15-M).

[00059] If code generators M+1 - N (15-(M+1) - 15-N) generating the dummy code group were not employed, determination would be performed to identify the one among code generators 1 - M (15-1 - 15-M), which generated the frame timing code and the code group exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code group would be detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the code groups generated by code generators 1 - M (15-1 - 15-M), one of them would be detected as the code group, and this detection would be error in many cases.

[00060] In contrast to the above, code generators M+1 - N (15-(M+1) - 15-N) generate the frame timing codes and the dummy codes, and calculation is performed to determine the correlation of the received code with respect to the frame timing codes and the dummy code group generated by code generators M+1 - N (15-(M+1) - 15-N). When the result exhibits the highest correlation, it is determined that any code group is not detected so that erroneous detection of the code group is prevented.

[00061] Fig. 5 is a block diagram showing a schematic structure of code detector 7'. Code detector 7' includes code generators 1 - N (19-1 - 19-M) which generate codes for detecting the codes, code generators M+1 - N (19-(M+1) - 19-N) which generates dummy codes, correlators 1 - N (20-1 - 20-N) which calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (19-1 - 19-N), a comparator 21 which compares the correlation values output from correlators 1 - N (20-1 - 20-N), and a determining unit 22 which determines a code exhibiting a high correlation based on the result of comparison by comparator 21.

[00062] Code generators 1 - M (19-1 - 19-M) generate the codes for detecting original codes. Meanwhile, code generators M+1 - N (19-(M+1) - 19-N) are employed for generating the codes for detecting the dummy code, and are configured to generate the dummy codes, which are different from the codes generated by code generators 1 - M (19-1 - 19-M).

[00063] If code generators M+1 - N (19-(M+1) - 19-N) generating the dummy codes were not employed, determination would be performed to identify the one among code generators 1 - M (19-1 - 19-M), which generated the code exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code is detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the codes generated by code generators 1 - M (19-1 - 19-M), one of them would be detected as the code, and this detection would be error in many cases.

[00064] In contrast to the above, code generators M+1 - N (19-1 - 19-N) generate the frame timing codes and the codes. In the case where the highest correlation is present between the dummy code generated by code generators M+1 - N (19-(M+1) - 19-N) and the received code, it is determined that the code is not received so that erroneous detection of the code is prevented.

[00065] According to the mobile communication terminal of this embodiment, as described above, the code generators generate the dummy code group or dummy codes, and detection of the code group or code is not performed if the received code exhibits a high correlation with respect to the dummy code group or the dummy code. Therefore, erroneous detection of the code group or code can be prevented.

(Third Embodiment)

[00066] A mobile communication terminal of a third embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated.

[00067] Fig. 6 is a flowchart showing a processing procedure of the mobile communication terminal of the third embodiment. In this flowchart, m indicates a number of operations of searching the slot, and n' indicates the number of paths detected in a step S12. For example, if one slot is searched by four divided operations, m is equal to 4, and n' represents the number of paths detected in this processing.

[00068] When microcomputer 4 instructs slot timing detector 5 to detect the slot timing (S11), slot timing detector 5 detects the search code of the slot, and thereby detects the slot timing applied from each base station (S12). The number of paths detected in this processing is represented by n' as described above.

[00069] Then, microcomputer 4 instructs detection of the frame timing and identification of the spread codes to frame timing and code group detector 6 and code detector 7 (S13). When frame timing and code group detector 6 receives the instruction for identification of the spread codes, calculation is performed to determine

the correlation between the received data in a search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code group is detected (S14). When code detector 7 receives the instruction for identification of the spread codes, the calculation is performed to determine the correlation between the received data in the search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code is detected (S15).

[00070] Microcomputer 4 discriminates between the multipath and the paths sent from different base stations based on the spread codes, which is identified by frame timing and code group detector 6 and code detector 7, and deletes the multipath if is detected (S16).

[00071] Fig. 7 shows detection of the multipath. When the slot indicated by shown in Fig. 7 is received, slot timing of each of slots, which are multiplexed in one slot, is detected (S12 in Fig. 6). As indicated by in Fig. 7, the frame timing and code group are detected (S14 in Fig. 6). As indicated by in Fig. 7, the code is detected (S15 in Fig. 6). The frame timing, code group and code are successively detected by performing the search m times (m: time of search operations).

[00072] As indicated by in Fig. 7, when the spread codes is identified, it is determined for the paths detected in the same slot whether the multipath is present or not based on whether the same spread codes are detected for a time period not exceeding a predetermined time (S16 in Fig. 6). For example, in the slot at the left end, two paths are detected within the predetermined time, and both exhibit the spread codes of "C_3" so that the latter path is determined as the multipath, and is deleted. Two paths detected in the second left slot are detected within the predetermined time, but exhibit different spread codes "C_7" and "C_2" so that these are determined as carrier waves coming from different base stations, respectively. Further, two paths in the slot at the right end are not detected within the predetermined time, and therefore are determined that these are not multipath.

[00073] Again, the flowchart of Fig. 6 will be described. Microcomputer 4 then instructs demodulator 8 and decoder 9 to start demodulation and decoding of the received data (S17). Demodulator 8 and decoder 9 start the demodulation and decoding in accordance with the instructions sent from microcomputer 4 (S18). In this processing, the multipath is already deleted so that the times required for demodulation and decoding can be short.

[00074] Microcomputer 4 performs the processing of determining validity/invalidity of the received data in parallel with the processing by demodulator 8 and decoder 9 (S19). If the received data is valid, the received data is stored in a table 31. If invalid, microcomputer 4 instructs demodulator 8 and decoder 9 to stop the

processing. Since processing by microcomputer 4 in steps S13, S16, S17 and S19, the processing by frame timing and code group detector 6 and code detector 7 in steps S14 and S15, and the processing by demodulator 8 and decoder 9 in step S18 can be performed in parallel with each other so that these can be performed as pipeline processing, whereby the cell search can be performed further fast.

[00075] The processing in steps S13 - S19 described above are performed for i = 0 - n'-1, and the processing is effected on the detected paths of n' in number. When the processing on the detected paths of n' in number is completed, the processing returns to step S11, and processing for the next search ranges is successively performed.

[00076] According to the mobile communication terminal of the embodiment, as described above, one slot is divided into a plurality of search ranges, and identification of the spread codes, deletion of the multipath, and demodulation and decoding of the received data are successively performed in the search ranges thus divided. Therefore, the time required for decoding the multipath can be reduced so that the cell search can be performed fast. Further, it is not necessary to employ a memory of a large capacity, which is required in the prior art for storing information used for deleting the multipath. Accordingly, the scale of hardware of the mobile communication terminal can be reduced.

[00077] Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

CLAIMS

1. A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2);

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid cell.

2. The mobile communication terminal according to claim 1, wherein

said control unit (4) determines the invalid cell based on information received from the base station, and stops the processing of said cell.

3. The mobile communication terminal according to claim 2, wherein

said detector (5, 6, 7) includes:

a slot timing detector (5) detecting slot timing from the signals received by said receiver (2),

a code group detector (6) detecting a code group based on the slot timing detected by said slot timing detector (5) from the signals received by said receiver (2), and

a code detector (7) detecting a code based on the slot timing detected by said slot timing detector (5) and the code group detected by said code group detector from the signals received by said receiver (2).

4. The mobile communication terminal according to claim 3, wherein

said control unit (4) stops the processing of received signals when the code group detected by said code group detector (6) is not a predetermined code.

5. The mobile communication terminal according to claim 4, wherein

said code group detector (6) includes:

a plurality of code generators (15-1 - 15-N), each of said code generators (15-1 - 15-M) generating a code corresponding to a different code group,

a dummy code generator (15-(M+1) - 15-N) generating a dummy code different from the code groups generated by said plurality of code generators (15-1 - 15-M),

a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 - 16-N) calculating correlation between the signal received by said receiver (2) and the code generated by the corresponding code generator (15-1 - 15-N), and

a determining unit (18) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (16-1 - 16-N).

6. The mobile communication terminal according to claim 3, wherein

said control unit (4) stops the signal processing of the cell search if the code detector (7) detects a code group other than a code group including the predetermined code.

7. The mobile communication terminal according to claim 6, wherein

said code detector (7) includes:

a plurality of code generators (19-1 - 19-N), each of said code generators (19-1 - 19-M) generating a different code,

a dummy code generator (19-(M+1) - 19-N) generating a dummy code different from the codes generated by said plurality of code generators (19-1 - 19-M),

a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N), and

a determining unit (22) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) dividing a slot into a plurality of search ranges, deleting multipath in said search range, successively allowing said demodulator (8) to demodulate the received signals and allowing said decoder (9) to decode the demodulated data.

9. The mobile communication terminal according to claim 8, wherein

said control unit (4) stops the decode processing if the decoded data in said search range is invalid data.

10. A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

demodulating the received signals with said detected spread codes;

decoding said demodulated data; and

controlling cell search process, and stopping signal processing of the cell search if said demodulated data is invalid cell.

11. The communication method according to claim 10, wherein

said step of stopping the signal processing of the cell search includes the step of determining invalid cell based on information received from the base station, and stopping the signal processing of the cell search.

12. The communication method according to claim 11, wherein

said step of detecting the spread codes includes the steps of:

detecting slot timing from said received signals,

detecting a code group based on said detected slot timing from said received signals, and

detecting a code based on said detected slot timing and said detected code group.

13. The communication method according to claim 12, wherein

said step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code group received from the base station is not a code group including a predetermined code.

14. The communication method according to claim 13, wherein

said step of stopping the signal processing of the cell search includes the steps of:

generating codes corresponding to a plurality of different code groups,

generating a dummy code different from said plurality of generated code groups,

calculating correlations of said received signals with respect to said plurality of generated code and the dummy code, and

determining invalidity of the detected code group based on a result of said calculation.

15. The communication method according to claim 12, wherein

said step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code received from the base station is not a predetermined code.

16. The communication method according to claim 15, wherein

said step of stopping the signal processing of the cell search includes the steps of:

generating a plurality of different codes,

generating a dummy code different from said generated code,

calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and

determining invalidity of the data based on a result of said calculation.

17. A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

deleting multipath of the code already detected;

successively demodulating the received signals subjected to the deletion of the multipath with said detected spread codes; and

decoding said demodulated data.

18. The communication method according to claim 17, wherein

said decoding processing is not performed in said step of deleting the multipath if the newly detected code is the multipath.

ABSTRACT

A mobile communication terminal includes a receiver (2) receiving a radio wave from base stations, a detector (5, 6, 7) detecting spread codes from the signal received by the receiver (2), a demodulator (8) demodulating the received signal with the spread codes detected by the detector (5, 6, 7), a decoder (9) decoding data demodulated by the demodulator (8), and a control unit (4) controlling processing during cell search, and stopping processing of the data in response to reception of invalid data. Since the control unit (4) stops the processing of the data if it receives the invalid data, the cell search can be performed fast.

Marked-up Copy of Amended Specification

SPECIFICATION

Mobile Communication Terminal and Communication Method

Technical Field

The present invention relates to a mobile communication terminal employing a code division multiplex method for communication, and particularly a mobile communication terminal which rapidly searches adjacent cells during cell search.

Background Art

In recent years, mobile communication terminals such as a portable telephone and a mobile telephone have been widely used, and various kinds of multiple access methods have been developed for use in such mobile communication systems. Among them, a CDMA (Code Division Multiple Access) method has been employed in portable telephones and others because it has high quality reception capability through the exploitation of multipath fading, and can achieve a high utilization efficiency of radio resource (can increase a subscriber capacity).

Fig. 8 is a schema which shows that the mobile station can receive a number of radio waves transmitted from adjacent cells via multiple propagation paths (multipath). In general, a plurality of base stations (BS1 - BS5) are arranged regularly, and cells of the base stations form a regular polygon if these base stations are arranged to cover a service area with as high a electric field as possible, as is well known and shown in Fig. 8. When a mobile communication terminal (MS) performs the cell search, it receives a plurality of radio waves from respective base stations, and additionally receives radio waves (multipath), which are transmitted from various base stations, and are shifted in timing from each other due to wave reflection and diffraction. This multipath is not necessary, and therefore is deleted during the cell search operation by an appropriate manner.

A stepwise search method has been known as a fast cell search method. Fig. 9 shows a processing procedure for detecting and deleting multipath components in the stepwise search method. First, slot timing for those including multipath components is detected (short-period detection) (S101). Detection of slots is performed by detecting search codes of the slots. By detecting the frame timing code, the frame timing is

detected (long-period detection), and further the code group is detected (S102).

In addition to the code group, the candidate codes which belong to the group is further evaluated (S103), and finally a spread codes is identified. Information such as spread codes, which is required for recognizing the multipath, is stored in a memory 110 (S104). In this manner, the multipath is recognized based on the information of code and timing stored in memory 110, and the multipath is deleted from the obtained information (S105). The information, from which the multipath is deleted as described above, is decoded so that an amount of decode processing is reduced, and fast cell search can be achieved.

However, the multipath is deleted after all the slot timing, frame timing and codes for one slot are detected and stored in memory 110. This results in a problem that the time required for the entire cell search cannot be reduced.

The invention has been developed for overcoming the above problem, and a first object of the invention is to provide a mobile communication terminal allowing fast cell search.

A second object of the invention is to provide a mobile communication terminal allowing accurate identification of spread codes.

A third object of the invention is to provide a communication method allowing fast cell search.

A fourth object of the invention is to provide a communication method allowing precise identification of spread codes.

Disclosure of the Invention

According to an aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver; a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid [data] cell.

The control unit stops the signal processing of the cell search when invalid [data] cell is received. Therefore, the cell search can be performed fast.

Preferably, the control unit determines the invalid [data] cell based on the

information received from the base station, and stops the processing of the [data] cell.

Since the control unit stops the processing of the [data] cell based on the information received from the base station, the cell search can be performed fast even in the cases, e.g., of erroneous detection of an unexisting code or frame timing.

The detector includes a slot timing detector detecting slot timing from the [data] signals received by the receiver, a code group detector detecting a code group based on the slot timing detected by the slot timing detector from the signals received by the receiver, and a code detector detecting a code based on the slot timing detected by the slot timing detector and the code group detected by the code group detector from the signals received by the receiver.

The code group detector and the code detector detect the code group and the code based on the slot timing detected by the slot timing detector, respectively. Therefore, the identification of the spread codes of each slot can be accurately performed.

More preferably, the control portion stops the processing of received data when the code group detected by the code group detector is not a predetermined code.

Since the control [portion] unit stops the processing of received [data] signals in the case where the code group detected by the code group detector is not the predetermined code, the cell search processing can be performed fast even in the case where an unexisting code group is erroneously detected.

More preferably, the code group detector includes a plurality of code generators generating a code corresponding to a different code group, a dummy code generator generating a dummy code different from the code group generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators and a determining unit determining invalidity of [data] the detected slot timing based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, it is possible to detect an inappropriate code group.

More preferably, the control unit stops the signal processing of the [received data] cell search if the code detector detects the code group other than the code group including the predetermined code.

Since the control unit stops the signal processing of the [received data] cell search if the code detector detects the code other than the predetermined code, the processing of cell search can be performed fast even if an unexisting code is erroneously detected.

More preferably, the code detector includes a plurality of code generators generating different codes, respectively, a dummy code generator generating a dummy code different from the codes generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators, and a determining unit determining invalidity of the [data] detected slot timing based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, an inappropriate code can be detected.

According to another aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver, a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit dividing a slot into a plurality of search ranges, deleting multipath in the search range [and], successively [decoding the received data by the decoder] allowing the demodulator to demodulate the received signals and allowing the decoder to decode the demodulated data.

The control unit divides the slot into a plurality of search ranges, deletes the multipath in the search range, and allows the decoder to decode successively the received data. Therefore, the data processing by the decoder can be reduced, and the cell search processing can be performed fast. Further, the detector, demodulator, decoder and control portion can be operated in parallel to perform pipeline processing so that the processing speed can be further increased.

Preferably, the control unit stops the decode processing if the [received] decoded data in the search range is invalid data.

Since the control portion stops the decode processing if the [received] decoded data in the search range is invalid data, the time required for the cell search can be further reduced.

According to further another aspect of the invention, a communication method

includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; demodulating the received signals with the detected spread codes; decoding the demodulated data; and controlling a cell search process, and stopping the signal processing of the cell search if the [received] demodulated data is invalid.

If the [received] demodulated data is invalid, the signal processing of the [received data] cell search is stopped so that the cell search can be performed fast.

Preferably, the step of stopping the signal processing of the [received data] cell search includes the step of determining invalid [data] cell based on the information received from the base station, and stopping the signal processing of the [data] cell search.

Since the signal processing of the [data] cell search is stopped based on the information received from the base station, the cell search can be performed fast, for example, even in the case where an unexisting code is detected.

More preferably, the step of detecting the spread codes includes the steps of detecting slot timing from the received [data] signals, detecting a code group based on the detected slot timing from the received signals, and detecting a code based on the detected slot timing and the detected code group.

Since the code group and the code are detected based on the detected slot timing, the spread codes of each slot can be accurately identified.

More preferably, the step of stopping the [data] signal processing of the cell search includes the step of stopping the signal processing of the [received data] cell search if the code group received from the base station is not a code group including a predetermined code.

Since the signal processing of the [received data] cell search is stopped if the code group is not the code group including the predetermined code, the processing of cell search can be performed further fast if inappropriate data is received from the base station.

More preferably, the step of stopping the signal processing of the [received data] cell search includes the steps of generating codes corresponding to a plurality of different code groups, respectively, generating a dummy code different from the plurality of generated code groups, calculating the correlation of the received data with respect to the plurality of generated code and the dummy code, and determining

invalidity of the [data] detected code group based on a result of the calculation.

Since the correlation between the received data and the generated code is calculated, an inappropriate code group can be detected.

More preferably, the step of stopping the signal processing of the [data] cell search includes the step of stopping the signal processing of the [received data] cell search if the code received from the base station is not a predetermined code.

If the code is different from the predetermined code, the signal processing of the [received data] cell search is stopped so that the cell search processing can be performed further fast even if an unexisting code group is erroneously detected.

More preferably, the step of stopping the [data] signal processing of the cell search includes the steps of generating a plurality of different codes, generating a dummy code different from the generated code, calculating a correlation of the received data with respect to the plurality of generated codes and the dummy code, and determining invalidity of the data based on a result of the calculation.

Since the correlation between the received data and the generated code is calculated, an inappropriate code can be detected.

According to still another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; deleting multipath of the code already detected; successively demodulating the received [data] signals subjected to the deletion of the multipath with the detected spread codes; and decoding the demodulated data.

The multipath of the code already detected is deleted, and the received data is successively demodulated and decoded. Therefore, the decode processing can be eliminated, and the processing of cell search can be performed fast.

Preferably, the decoding processing is not performed in the step of deleting the multipath if the newly detected code is the multipath.

Since the decode processing is not performed if the newly detected code is the multipath, the time required for the cell search can be further reduced.

Brief Description of the Drawings

Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention;

Fig. 2 is a block diagram showing schematic structures of a frame timing and

code group detector 6 and a code detector 7 of the mobile communication terminal of the first embodiment of the invention;

Fig. 3 is a flowchart for showing a processing procedure of the mobile communication terminal of the first embodiment of the invention;

Fig. 4 is a block diagram showing a schematic structure of a frame timing and code group detector 6' of a mobile communication terminal of a second embodiment of the invention;

Fig. 5 is a block diagram showing a schematic structure of a code detector 7' of the mobile communication terminal of the second embodiment of the invention;

Fig. 6 is a flowchart showing a processing procedure of a mobile communication terminal of a third embodiment of the invention;

Fig. 7 shows determination of a multipath component;

Fig. 8 shows that MS receives radio waves which include multipath components from adjacent cells;

Fig. 9 is a flowchart showing recognisition and deletion of the multipath component during cell search in the prior art.

Best Mode for Carrying Out the Invention

The invention will now be described in greater detail with reference to the drawings.

(First Embodiment)

Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention. This mobile communication terminal includes an antenna 1, a receiver 2 which receives a weak radio frequency wave sent from base stations via antenna 1 and down-converts that into a baseband frequency wave, an A/D (Analog-to-Digital) converter 3 which converts received analog signals into digital signals, a microcomputer 4 which performs entire control of the mobile communication terminal, a slot timing detector 5 for detecting slot timing during cell search, a frame timing and code group detector 6 which detects frame timing and code group during cell search, a code detector 7 which detects a code during cell search, a demodulator 8 which demodulates a received code with a detected spread codes, a decoder 9 which decodes the received signals demodulated by demodulator 8, and a memory 10 which stores a program to be executed by

microcomputer 4 and others. The detection of the frame timing may be performed by code detector 7.

Fig. 2 is a block diagram showing a schematic structure of frame timing and code group detector 6. Frame timing and code group detector 6 includes code generators 1 - N (11-1 - 11-N) generating codes, which are used when detecting a code group, correlators 1 - N (12-1 - 12-N) which calculates correlations between a digital signal sent from A/D converter 3 and the codes generated by code generators 1 - N (11-1 - 11-N), a comparator 13 comparing correlation values output from correlators 1 - N (12-1 - 12-N), and a determining unit 14 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 13. The result of determination of determining unit 14 is stored in memory 10.

Code detector 7 has a structure similar to that of frame timing and code group detector 6 shown in Fig. 2. However, code generators 1 - N (11-1 - 11-N) do not generate the codes for detecting the code group, but generate the codes for detecting the codes so that correlators 1 - N (12-1 - 12-N) calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (11-1 - 11-N).

Fig. 3 is a flowchart showing a processing procedure of the mobile communication terminal of the first embodiment of the invention. First, slot timing detector 5 receives the digital signal sent from A/D converter 3, and detects the slot timing (S1). Frame timing and code group detector 7 detects the frame timing from the digital signal sent from A/D converter 3 using the frame timing code, and detects the code group based on the slot timing detected by slot timing detector 5 (S2).

Then, microcomputer 4 determines whether the frame timing and code group detected by frame timing and code group detector 6 are valid or not (S3). For example, it is determined that the code group is invalid if there is no code group exhibiting a high correlation, as will be described later in connection with a second embodiment. If it is determined that the frame timing or code group is invalid (invalid in S3), microcomputer 4 ends the processing as it is. If it is determined that the frame timing and code group are valid (valid in S3), microcomputer 4 operates to detect the code by code detector 7 (S4).

Then, microcomputer 4 determines whether the code detected by code detector 7 is valid or not (S5). For example, it is determined that the code is invalid if the code

exhibiting a high correlations is not present, as will be described later in connection with the second embodiment. When it is determined that the code is invalid (invalid in S4), microcomputer 4 stops the processing as it is. When it is determined that the code is valid (valid in S4), microcomputer 4 stores the code in memory 10. The multipath is detected and deleted from the code stored in memory 10 (S7). Decoder 9 decodes the data demodulated by demodulator 8 to acquire the notification information, and the processing ends.

According to the mobile communication terminal of this embodiment, as described above, the information is not stored, and the processing stops if the frame timing, code group or code is invalid. Therefore, the detection of the multipath during the cell search can be efficiently performed, and the processing speed can be improved.

(Second Embodiment)

A mobile communication terminal of a second embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the structures of the frame timing and code group detector and the code detector as well as the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated. In the second embodiment, the frame timing and code group detector and the code detector bear the reference numbers 6' and 7', respectively.

Fig. 4 is a block diagram showing a schematic structure of frame timing and code group detector 6' of the second embodiment. Frame timing and code group detector 6' includes code generators 1 - M (15-1 - 15-M) generating codes for detecting the frame timing and the code group, code generators M+1 - N (15-(M+1) - 15-N) generating dummy codes, correlators 1 - N (16-1 - 16-N) which calculate correlations between the digital signals sent from A/D converter 3 and the codes output from code generators 1 - N (15-1 - 15-N), a comparator 17 which compares correlation values output from correlators 1 - N (16-1 - 16-N), and a determining unit 18 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 17.

Code generators 1 - M (15-1 - 15-M) generate codes for detecting the original frame timing code and code group. Meanwhile code generators M+1 - N (15-(M+1) - 15-N) are employed for generating codes for detecting the frame timing code and dummy code group, and thus generate the dummy codes different from the codes

generated by code generators 1 - M (15-1 - 15-M).

If code generators M+1 - N (15-(M+1) - 15-N) generating the dummy code group were not employed, determination would be performed to identify the one among code generators 1 - M (15-1 - 15-M), which generated the frame timing code and the code group exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code group would be detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the code groups generated by code generators 1 - M (15-1 - 15-M), one of them would be detected as the code group, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (15-(M+1) - 15-N) generate the frame timing codes and the dummy codes, and calculation is performed to determine the correlation of the received code with respect to the frame timing codes and the dummy code group generated by code generators M+1 - N (15-(M+1) - 15-N). When the result exhibits the highest correlation, it is determined that any code group is not detected so that erroneous detection of the code group is prevented.

Fig. 5 is a block diagram showing a schematic structure of code detector 7'. Code detector 7' includes code generators 1 - N (19-1 - 19-M) which generate codes for detecting the codes, code generators M+1 - N (19-(M+1) - 19-N) which generates dummy codes, correlators 1 - N (20-1 - 20-N) which calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (19-1 - 19-N), a comparator 21 which compares the correlation values output from correlators 1 - N (20-1 - 20-N), and a determining unit 22 which determines a code exhibiting a high correlation based on the result of comparison by comparator 21.

Code generators 1 - M (19-1 - 19-M) generate the codes for detecting original codes. Meanwhile, code generators M+1 - N (19-(M+1) - 19-N) are employed for generating the codes for detecting the dummy code, and are configured to generate the dummy codes, which are different from the codes generated by code generators 1 - M (19-1 - 19-M).

If code generators M+1 - N (19-(M+1) - 19-N) generating the dummy codes were not employed, determination would be performed to identify the one among code generators 1 - M (19-1 - 19-M), which generated the code exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the

code is detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the codes generated by code generators 1 - M (19-1 - 19-M), one of them would be detected as the code, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (19-1 - 19-N) generate the frame timing codes and the codes. In the case where the highest correlation is present between the dummy code generated by code generators M+1 - N (19-(M+1) - 19-N) and the received code, it is determined that the code is not received so that erroneous detection of the code is prevented.

According to the mobile communication terminal of this embodiment, as described above, the code generators generate the dummy code group or dummy codes, and detection of the code group or code is not performed if the received code exhibits a high correlation with respect to the dummy code group or the dummy code. Therefore, erroneous detection of the code group or code can be prevented.

(Third Embodiment)

A mobile communication terminal of a third embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated.

Fig. 6 is a flowchart showing a processing procedure of the mobile communication terminal of the third embodiment. In this flowchart, m indicates a number of operations of searching the slot, and n' indicates the number of paths detected in a step S12. For example, if one slot is searched by four divided operations, m is equal to 4, and n' represents the number of paths detected in this processing.

When microcomputer 4 instructs slot timing detector 5 to detect the slot timing (S11), slot timing detector 5 detects the search code of the slot, and thereby detects the slot timing applied from each base station (S12). The number of paths detected in this processing is represented by n' as described above.

Then, microcomputer 4 instructs detection of the frame timing and identification of the spread codes to frame timing and code group detector 6 and code detector 7 (S13). When frame timing and code group detector 6 receives the instruction for identification of the spread codes, calculation is performed to determine the correlation between the received data in a search range j of the slot and the code

groups generated by code generators 1 - N, and thereby the code group is detected (S14). When code detector 7 receives the instruction for identification of the spread codes, the calculation is performed to determine the correlation between the received data in the search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code is detected (S15).

Microcomputer 4 discriminates between the multipath and the paths sent from different base stations based on the spread codes, which is identified by frame timing and code group detector 6 and code detector 7, and deletes the multipath if is detected (S16).

Fig. 7 shows detection of the multipath. When the slot indicated by shown in Fig. 7 is received, slot timing of each of slots, which are multiplexed in one slot, is detected (S12 in Fig. 6). As indicated by in Fig. 7, the frame timing and code group are detected (S14 in Fig. 6). As indicated by in Fig. 7, the code is detected (S15 in Fig. 6). The frame timing, code group and code are successively detected by performing the search m times (m: time of search operations).

As indicated by in Fig. 7, when the spread codes is identified, it is determined for the paths detected in the same slot whether the multipath is present or not based on whether the same spread codes are detected for a time period not exceeding a predetermined time (S16 in Fig. 6). For example, in the slot at the left end, two paths are detected within the predetermined time, and both exhibit the spread codes of "C_3" so that the latter path is determined as the multipath, and is deleted. Two paths detected in the second left slot are detected within the predetermined time, but exhibit different spread codes "C_7" and "C_2" so that these are determined as carrier waves coming from different base stations, respectively. Further, two paths in the slot at the right end are not detected within the predetermined time, and therefore are determined that these are not multipath.

Again, the flowchart of Fig. 6 will be described. Microcomputer 4 then instructs demodulator 8 and decoder 9 to start demodulation and decoding of the received data (S17). Demodulator 8 and decoder 9 start the demodulation and decoding in accordance with the instructions sent from microcomputer 4 (S18). In this processing, the multipath is already deleted so that the times required for demodulation and decoding can be short.

Microcomputer 4 performs the processing of determining validity/invalidity of

the received data in parallel with the processing by demodulator 8 and decoder 9 (S19). If the received data is valid, the received data is stored in a table 31. If invalid, microcomputer 4 instructs demodulator 8 and decoder 9 to stop the processing. Since processing by microcomputer 4 in steps S13, S16, S17 and S19, the processing by frame timing and code group detector 6 and code detector 7 in steps S14 and S15, and the processing by demodulator 8 and decoder 9 in step S18 can be performed in parallel with each other so that these can be performed as pipeline processing, whereby the cell search can be performed further fast.

The processing in steps S13 - S19 described above are performed for i = 0 - n'-1, and the processing is effected on the detected paths of n' in number. When the processing on the detected paths of n' in number is completed, the processing returns to step S11, and processing for the next search ranges is successively performed.

According to the mobile communication terminal of the embodiment, as described above, one slot is divided into a plurality of search ranges, and identification of the spread codes, deletion of the multipath, and demodulation and decoding of the received data are successively performed in the search ranges thus divided. Therefore, the time required for decoding the multipath can be reduced so that the cell search can be performed fast. Further, it is not necessary to employ a memory of a large capacity, which is required in the prior art for storing information used for deleting the multipath. Accordingly, the scale of hardware of the mobile communication terminal can be reduced.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

Marked-up Copy of Amended Claims

CLAIMS

1. (Amended) A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2);

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid [data] cell.

2. (Amended) The mobile communication terminal according to claim 1, wherein

said control unit (4) determines the invalid [data] cell based on information received from the base station, and stops the processing of said [data] cell.

3. (Amended) The mobile communication terminal according to claim 2, wherein

said detector (5, 6, 7) includes:

a slot timing detector (5) detecting slot timing from the signals received by said receiver (2),

a code group detector (6) detecting a code group based on the slot timing detected by said slot timing detector (5) from the signals received by said receiver (2), and

a code detector (7) detecting a code based on the slot timing detected by said slot timing detector (5) and the code group detected by said code group detector from the signals received by said receiver (2).

4. (Amended) The mobile communication terminal according to claim 3, wherein

said control unit (4) stops the processing of received [data] signals when the code group detected by said code group detector (6) is not a predetermined code.

5. (Amended) The mobile communication terminal according to claim 4, wherein

said code group detector (6) includes:

a plurality of code generators (15-1 - 15-N), each of said code generators (15-1 - 15-M) generating a code corresponding to a different code group,

a dummy code generator (15-(M+1) - 15-N) generating a dummy code different from the code groups generated by said plurality of code generators (15-1 - 15-M),

a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 - 16-N) calculating correlation between the signal received by said receiver (2) and the code generated by the corresponding code generator (15-1 - 15-N), and

a determining unit (18) determining invalidity of the [data] detected slot timing based on the calculation result of said plurality of correlators (16-1 - 16-N).

6. (Amended) The mobile communication terminal according to claim 3, wherein

said control unit (4) stops the signal processing of the [received data] cell search if the code detector (7) detects a code group other than a code group including the predetermined code.

7. (Amended) The mobile communication terminal according to claim 6, wherein

said code detector (7) includes:

a plurality of code generators (19-1 - 19-N), each of said code generators (19-1 - 19-M) generating a different code,

a dummy code generator (19-(M+1) - 19-N) generating a dummy code

different from the codes generated by said plurality of code generators (19-1 - 19-M),

a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N), and

a determining unit (22) determining invalidity of the [data] detected slot timing based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. (Amended) A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) dividing a slot into a plurality of search ranges, deleting multipath in said search range [and], successively [decoding the received data by said decoder (9)] allowing said demodulator (8) to demodulate the received signals and allowing said decoder (9) to decode the demodulated data.

9. (Amended) The mobile communication terminal according to claim 8, wherein

said control unit (4) stops the decode processing if the [received] decoded data in said search range is invalid data.

10. (Amended) A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

demodulating the received signals with said detected spread codes;

decoding said demodulated data; and

controlling cell search process, and stopping signal processing of the cell search if said [received] demodulated data is invalid cell.

11. (Amended) The communication method according to claim 10, wherein

said step of stopping the signal processing of the cell search includes the step of determining invalid [data] cell based on information received from the base station, and stopping the signal processing of the [data] cell search.

12. (Amended) The communication method according to claim 11, wherein

said step of detecting the spread codes includes the steps of:

detecting slot timing from said received signals,

detecting a code group based on said detected slot timing from said received signals, and

detecting a code based on said detected slot timing and said detected code group.

13. (Amended) The communication method according to claim 12, wherein

said step of stopping the signal processing of [said received data] the cell search includes the step of stopping the signal processing of the cell search if the code group received from the base station is not a code group including a predetermined code.

14. (Amended) The communication method according to claim 13, wherein

said step of stopping the signal processing of the cell search includes the steps of:

generating codes corresponding to a plurality of different code groups,

generating a dummy code different from said plurality of generated code groups,

calculating correlations of said received signals with respect to said plurality of generated code and the dummy code, and

determining invalidity of the [data] detected code group based on a result of said calculation.

15. (Amended) The communication method according to claim 12, wherein

said step of stopping the signal processing of [said received data] the cell search includes the step of stopping the signal processing of the [received data] cell search if the code received from the base station is not a predetermined code.

16. (Amended) The communication method according to claim 15, wherein

said step of stopping the signal processing of [said received data] the cell search includes the steps of:

generating a plurality of different codes,

generating a dummy code different from said generated code,

calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and

determining invalidity of the data based on a result of said calculation.

17. (Amended) A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

deleting multipath of the code already detected;

successively demodulating the received [data] signals subjected to the deletion of the multipath with said detected spread codes; and

decoding said demodulated data.

SPECIFICATION

Mobile Communication Terminal and Communication Method

Technical Field

The present invention relates to a mobile communication terminal employing a code division multiplex method for communication, and particularly a mobile communication terminal which rapidly searches adjacent cells during cell search.

Background Art

In recent years, mobile communication terminals such as a portable telephone and a mobile telephone have been widely used, and various kinds of multiple access methods have been developed for use in such mobile communication systems. Among them, a CDMA (Code Division Multiple Access) method has been employed in portable telephones and others because it has high quality reception capability through the exploitation of multipath fading, and can achieve a high utilization efficiency of radio resource (can increase a subscriber capacity).

Fig. 8 is a schema which shows that the mobile station can receive a number of radio waves transmitted from adjacent cells via multiple propagation paths (multipath). In general, a plurality of base stations (BS1 - BS5) are arranged regularly, and cells of the base stations form a regular polygon if these base stations are arranged to cover a service area with as high a electric field as possible, as is well known and shown in Fig. 8. When a mobile communication terminal (MS) performs the cell search, it receives a plurality of radio waves from respective base stations, and additionally receives radio waves (multipath), which are transmitted from various base stations, and are shifted in timing from each other due to wave reflection and diffraction. This multipath is not necessary, and therefore is deleted during the cell search operation by an appropriate manner.

A stepwise search method has been known as a fast cell search

method. Fig. 9 shows a processing procedure for detecting and deleting multipath components in the stepwise search method. First, slot timing for those including multipath components is detected (short-period detection) (S101). Detection of slots is performed by detecting search codes of the slots. By detecting the frame timing code, the frame timing is detected (long-period detection), and further the code group is detected (S102).

In addition to the code group, the candidate codes which belong to the group is further evaluated (S103), and finally a spread codes is identified. Information such as spread codes, which is required for recognizing the multipath, is stored in a memory 110 (S104). In this manner, the multipath is recognized based on the information of code and timing stored in memory 110, and the multipath is deleted from the obtained information (S105). The information, from which the multipath is deleted as described above, is decoded so that an amount of decode processing is reduced, and fast cell search can be achieved.

However, the multipath is deleted after all the slot timing, frame timing and codes for one slot are detected and stored in memory 110. This results in a problem that the time required for the entire cell search cannot be reduced.

The invention has been developed for overcoming the above problem, and a first object of the invention is to provide a mobile communication terminal allowing fast cell search.

A second object of the invention is to provide a mobile communication terminal allowing accurate identification of spread codes.

A third object of the invention is to provide a communication method allowing fast cell search.

A fourth object of the invention is to provide a communication method allowing precise identification of spread codes.

Disclosure of the Invention

According to an aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a

detector detecting spread codes from signals received by the receiver; a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit controlling cell search process, and stopping processing of the cell search in response to detection of invalid data.

The control unit stops the processing of the cell search when invalid data is received. Therefore, the cell search can be performed fast.

Preferably, the control unit determines the invalid data based on the information received from the base station, and stops the processing of the data.

Since the control unit stops the processing of the data cell based on the information received from the base station, the cell search can be performed fast even in the cases, e.g., of erroneous detection of an unexisting code or frame timing.

The detector includes a slot timing detector detecting slot timing from the data received by the receiver, a code group detector detecting a code group based on the slot timing detected by the slot timing detector, and a code detector detecting a code based on the slot timing detected by the slot timing detector.

The code group detector and the code detector detect the code group and the code based on the slot timing detected by the slot timing detector, respectively. Therefore, the identification of the spread codes of each slot can be accurately performed.

More preferably, the control portion stops the processing of received data when the code group detected by the code group detector is not a predetermined code.

Since the control portion stops the processing of received data in the case where the code group detected by the code group detector is not the predetermined code, the cell search processing can be performed fast even in the case where an unexisting code group is erroneously detected.

More preferably, the code group detector includes a plurality of code generators generating a different code group, a dummy code generator

generating a dummy code different from the code group generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators and a determining unit determining invalidity of data based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, it is possible to detect an inappropriate code group.

More preferably, the control unit stops the processing of the received data if the code detector detects the code other than the predetermined code.

Since the control unit stops the processing of the received data if the code detector detects the code other than the predetermined code, the processing of cell search can be performed fast even if an unexisting code is erroneously detected.

More preferably, the code detector includes a plurality of code generators generating different codes, respectively, a dummy code generator generating a dummy code different from the codes generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators, and a determining unit determining invalidity of the data based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, an inappropriate code can be detected.

According to another aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver, a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit dividing a slot into a

plurality of search ranges, deleting multipath in the search range and successively decoding the received data by the decoder.

The control unit divides the slot into a plurality of search ranges, deletes the multipath in the search range, and allows the decoder to decode successively the received data. Therefore, the data processing by the decoder can be reduced, and the cell search processing can be performed fast. Further, the detector, demodulator, decoder and control portion can be operated in parallel to perform pipeline processing so that the processing speed can be further increased.

Preferably, the control unit stops the decode processing if the received data in the search range is invalid data.

Since the control portion stops the decode processing if the received data in the search range is invalid data, the time required for the cell search can be further reduced.

According to further another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; demodulating the received signals with the detected spread codes; decoding the demodulated data; and controlling a cell search process, and stopping the processing of the cell search if the received data is invalid.

If the received data is invalid, the processing of the received data is stopped so that the cell search can be performed fast.

Preferably, the step of stopping the processing of the received data includes the step of determining invalid data based on the information received from the base station, and stopping the processing of the data.

Since the processing of the data is stopped based on the information received from the base station, the cell search can be performed fast, for example, even in the case where an unexisting code is detected.

More preferably, the step of detecting the spread codes includes the steps of detecting slot timing from the received data, detecting a code group based on the detected slot timing, and detecting a code based on the detected slot timing.

Since the code group and the code are detected based on the detected

slot timing, the spread codes of each slot can be accurately identified.

More preferably, the step of stopping the data processing includes the step of stopping the processing of the received data if the code group received from the base station is not a predetermined code.

Since the processing of the received data is stopped if the code group is not the predetermined code, the processing of cell search can be performed further fast if inappropriate data is received from the base station.

More preferably, the step of stopping the processing of the received data includes the steps of generating a plurality of different code groups, respectively, generating a dummy code different from the plurality of generated code groups, calculating the correlation of the received data with respect to the plurality of generated code and the dummy code, and determining invalidity of the data based on a result of the calculation.

Since the correlation between the received data and the generated code is calculated, an inappropriate code group can be detected.

More preferably, the step of stopping the processing of the data includes the step of stopping the processing of the received data if the code received from the base station is not a predetermined code.

If the code is different from the predetermined code, the processing of the received data is stopped so that the cell search processing can be performed further fast even if an unexisting code group is erroneously detected.

More preferably, the step of stopping the data processing includes the steps of generating a plurality of different codes, generating a dummy code different from the generated code, calculating a correlation of the received data with respect to the plurality of generated codes and the dummy code, and determining invalidity of the data based on a result of the calculation.

Since the correlation between the received data and the generated code is calculated, an inappropriate code can be detected.

According to still another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations;

detecting spread codes from the received signals; deleting multipath of the code already detected; successively demodulating the received data subjected to the deletion of the multipath with the detected spread codes; and decoding the demodulated data.

The multipath of the code already detected is deleted, and the received data is successively demodulated and decoded. Therefore, the decode processing can be eliminated, and the processing of cell search can be performed fast.

Preferably, the decoding processing is not performed in the step of deleting the multipath if the newly detected code is the multipath.

Since the decode processing is not performed if the newly detected code is the multipath, the time required for the cell search can be further reduced.

Brief Description of the Drawings

Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention;

Fig. 2 is a block diagram showing schematic structures of a frame timing and code group detector 6 and a code detector 7 of the mobile communication terminal of the first embodiment of the invention;

Fig. 3 is a flowchart for showing a processing procedure of the mobile communication terminal of the first embodiment of the invention;

Fig. 4 is a block diagram showing a schematic structure of a frame timing and code group detector 6' of a mobile communication terminal of a second embodiment of the invention;

Fig. 5 is a block diagram showing a schematic structure of a code detector 7' of the mobile communication terminal of the second embodiment of the invention;

Fig. 6 is a flowchart showing a processing procedure of a mobile communication terminal of a third embodiment of the invention;

Fig. 7 shows determination of a multipath component;

Fig. 8 shows that MS receives radio waves which include multipath components from adjacent cells;

Fig. 9 is a flowchart showing recognisition and deletion of the multipath component during cell search in the prior art.

Best Mode for Carrying Out the Invention

The invention will now be described in greater detail with reference to the drawings.

(First Embodiment)

Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention. This mobile communication terminal includes an antenna 1, a receiver 2 which receives a weak radio frequency wave sent from base stations via antenna 1 and down-converts that into a baseband frequency wave, an A/D (Analog-to-Digital) converter 3 which converts received analog signals into digital signals, a microcomputer 4 which performs entire control of the mobile communication terminal, a slot timing detector 5 for detecting slot timing during cell search, a frame timing and code group detector 6 which detects frame timing and code group during cell search, a code detector 7 which detects a code during cell search, a demodulator 8 which demodulates a received code with a detected spread codes, a decoder 9 which decodes the received signals demodulated by demodulator 8, and a memory 10 which stores a program to be executed by microcomputer 4 and others. The detection of the frame timing may be performed by code detector 7.

Fig. 2 is a block diagram showing a schematic structure of frame timing and code group detector 6. Frame timing and code group detector 6 includes code generators 1 - N (11-1 - 11-N) generating codes, which are used when detecting a code group, correlators 1 - N (12-1 - 12-N) which calculates correlations between a digital signal sent from A/D converter 3 and the codes generated by code generators 1 - N (11-1 - 11-N), a comparator 13 comparing correlation values output from correlators 1 - N (12-1 - 12-N), and a determining unit 14 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 13. The result of determination of determining unit 14 is stored in memory 10.

Code detector 7 has a structure similar to that of frame timing and code group detector 6 shown in Fig. 2. However, code generators 1 - N (11-1 - 11-N) do not generate the codes for detecting the code group, but generate the codes for detecting the codes so that correlators 1 - N (12-1 - 12-N) calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (11-1 - 11-N).

Fig. 3 is a flowchart showing a processing procedure of the mobile communication terminal of the first embodiment of the invention. First, slot timing detector 5 receives the digital signal sent from A/D converter 3, and detects the slot timing (S1). Frame timing and code group detector 7 detects the frame timing from the digital signal sent from A/D converter 3 using the frame timing code, and detects the code group based on the slot timing detected by slot timing detector 5 (S2).

Then, microcomputer 4 determines whether the frame timing and code group detected by frame timing and code group detector 6 are valid or not (S3). For example, it is determined that the code group is invalid if there is no code group exhibiting a high correlation, as will be described later in connection with a second embodiment. If it is determined that the frame timing or code group is invalid (invalid in S3), microcomputer 4 ends the processing as it is. If it is determined that the frame timing and code group are valid (valid in S3), microcomputer 4 operates to detect the code by code detector 7 (S4).

Then, microcomputer 4 determines whether the code detected by code detector 7 is valid or not (S5). For example, it is determined that the code is invalid if the code exhibiting a high correlations is not present, as will be described later in connection with the second embodiment. When it is determined that the code is invalid (invalid in S4), microcomputer 4 stops the processing as it is. When it is determined that the code is valid (valid in S4), microcomputer 4 stores the code in memory 10. The multipath is detected and deleted from the code stored in memory 10 (S7). Decoder 9 decodes the data demodulated by demodulator 8 to acquire the notification information, and the processing ends.

According to the mobile communication terminal of this embodiment,

as described above, the information is not stored, and the processing stops if the frame timing, code group or code is invalid. Therefore, the detection of the multipath during the cell search can be efficiently performed, and the processing speed can be improved.

(Second Embodiment)

A mobile communication terminal of a second embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the structures of the frame timing and code group detector and the code detector as well as the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated. In the second embodiment, the frame timing and code group detector and the code detector bear the reference numbers 6' and 7', respectively.

Fig. 4 is a block diagram showing a schematic structure of frame timing and code group detector 6' of the second embodiment. Frame timing and code group detector 6' includes code generators 1 - M (15-1 - 15-M) generating codes for detecting the frame timing and the code group, code generators M+1 - N (15-(M+1) - 15-N) generating dummy codes, correlators 1 - N (16-1 - 16-N) which calculate correlations between the digital signals sent from A/D converter 3 and the codes output from code generators 1 - N (15-1 - 15-N), a comparator 17 which compares correlation values output from correlators 1 - N (16-1 - 16-N), and a determining unit 18 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 17.

Code generators 1 - M (15-1 - 15-M) generate codes for detecting the original frame timing code and code group. Meanwhile code generators M+1 - N (15-(M+1) - 15-N) are employed for generating codes for detecting the frame timing code and dummy code group, and thus generate the dummy codes different from the codes generated by code generators 1 - M (15-1 - 15-M).

If code generators M+1 - N (15-(M+1) - 15-N) generating the dummy code group were not employed, determination would be performed to identify the one among code generators 1 - M (15-1 - 15-M), which

generated the frame timing code and the code group exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code group would be detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the code groups generated by code generators 1 - M (15-1 - 15-M), one of them would be detected as the code group, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (15-(M+1) - 15-N) generate the frame timing codes and the dummy codes, and calculation is performed to determine the correlation of the received code with respect to the frame timing codes and the dummy code group generated by code generators M+1 - N (15-(M+1) - 15-N). When the result exhibits the highest correlation, it is determined that any code group is not detected so that erroneous detection of the code group is prevented.

Fig. 5 is a block diagram showing a schematic structure of code detector 7'. Code detector 7' includes code generators 1 - N (19-1 - 19-M) which generate codes for detecting the codes, code generators M+1 - N (19-(M+1) - 19-N) which generates dummy codes, correlators 1 - N (20-1 - 20-N) which calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (19-1 - 19-N), a comparator 21 which compares the correlation values output from correlators 1 - N (20-1 - 20-N), and a determining unit 22 which determines a code exhibiting a high correlation based on the result of comparison by comparator 21.

Code generators 1 - M (19-1 - 19-M) generate the codes for detecting original codes. Meanwhile, code generators M+1 - N (19-(M+1) - 19-N) are employed for generating the codes for detecting the dummy code, and are configured to generate the dummy codes, which are different from the codes generated by code generators 1 - M (19-1 - 19-M).

If code generators M+1 - N (19-(M+1) - 19-N) generating the dummy codes were not employed, determination would be performed to identify the one among code generators 1 - M (19-1 - 19-M), which generated the code exhibiting the highest correlation with respect to the digital signal sent

from A/D converter 3, and thereby the code is detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the codes generated by code generators 1 - M (19-1 - 19-M), one of them would be detected as the code, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (19-1 - 19-N) generate the frame timing codes and the codes. In the case where the highest correlation is present between the dummy code generated by code generators M+1 - N (19-(M+1) - 19-N) and the received code, it is determined that the code is not received so that erroneous detection of the code is prevented.

According to the mobile communication terminal of this embodiment, as described above, the code generators generate the dummy code group or dummy codes, and detection of the code group or code is not performed if the received code exhibits a high correlation with respect to the dummy code group or the dummy code. Therefore, erroneous detection of the code group or code can be prevented.

(Third Embodiment)

A mobile communication terminal of a third embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated.

Fig. 6 is a flowchart showing a processing procedure of the mobile communication terminal of the third embodiment. In this flowchart, m indicates a number of operations of searching the slot, and n' indicates the number of paths detected in a step S12. For example, if one slot is searched by four divided operations, m is equal to 4, and n' represents the number of paths detected in this processing.

When microcomputer 4 instructs slot timing detector 5 to detect the slot timing (S11), slot timing detector 5 detects the search code of the slot, and thereby detects the slot timing applied from each base station (S12). The number of paths detected in this processing is represented by n' as

described above.

Then, microcomputer 4 instructs detection of the frame timing and identification of the spread codes to frame timing and code group detector 6 and code detector 7 (S13). When frame timing and code group detector 6 receives the instruction for identification of the spread codes, calculation is performed to determine the correlation between the received data in a search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code group is detected (S14). When code detector 7 receives the instruction for identification of the spread codes, the calculation is performed to determine the correlation between the received data in the search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code is detected (S15).

Microcomputer 4 discriminates between the multipath and the paths sent from different base stations based on the spread codes, which is identified by frame timing and code group detector 6 and code detector 7, and deletes the multipath if is detected (S16).

Fig. 7 shows detection of the multipath. When the slot indicated by ① shown in Fig. 7 is received, slot timing of each of slots, which are multiplexed in one slot, is detected (S12 in Fig. 6). As indicated by ② in Fig. 7, the frame timing and code group are detected (S14 in Fig. 6). As indicated by ③ in Fig. 7, the code is detected (S15 in Fig. 6). The frame timing, code group and code are successively detected by performing the search m times (m: time of search operations).

As indicated by ③ in Fig. 7, when the spread codes is identified, it is determined for the paths detected in the same slot whether the multipath is present or not based on whether the same spread codes are detected for a time period not exceeding a predetermined time (S16 in Fig. 6). For example, in the slot at the left end, two paths are detected within the predetermined time, and both exhibit the spread codes of "C_3" so that the latter path is determined as the multipath, and is deleted. Two paths detected in the second left slot are detected within the predetermined time, but exhibit different spread codes "C_7" and "C_2" so that these are determined as carrier waves coming from different base stations,

respectively. Further, two paths in the slot at the right end are not detected within the predetermined time, and therefore are determined that these are not multipath.

Again, the flowchart of Fig. 6 will be described. Microcomputer 4 then instructs demodulator 8 and decoder 9 to start demodulation and decoding of the received data (S17). Demodulator 8 and decoder 9 start the demodulation and decoding in accordance with the instructions sent from microcomputer 4 (S18). In this processing, the multipath is already deleted so that the times required for demodulation and decoding can be short.

Microcomputer 4 performs the processing of determining validity/invalidity of the received data in parallel with the processing by demodulator 8 and decoder 9 (S19). If the received data is valid, the received data is stored in a table 31. If invalid, microcomputer 4 instructs demodulator 8 and decoder 9 to stop the processing. Since processing by microcomputer 4 in steps S13, S16, S17 and S19, the processing by frame timing and code group detector 6 and code detector 7 in steps S14 and S15, and the processing by demodulator 8 and decoder 9 in step S18 can be performed in parallel with each other so that these can be performed as pipeline processing, whereby the cell search can be performed further fast.

The processing in steps S13 - S19 described above are performed for i = 0 - n'-1, and the processing is effected on the detected paths of n' in number. When the processing on the detected paths of n' in number is completed, the processing returns to step S11, and processing for the next search ranges is successively performed.

According to the mobile communication terminal of the embodiment, as described above, one slot is divided into a plurality of search ranges, and identification of the spread codes, deletion of the multipath, and demodulation and decoding of the received data are successively performed in the search ranges thus divided. Therefore, the time required for decoding the multipath can be reduced so that the cell search can be performed fast. Further, it is not necessary to employ a memory of a large capacity, which is required in the prior art for storing information used for

deleting the multipath. Accordingly, the scale of hardware of the mobile communication terminal can be reduced.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

CLAIMS

1. A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2);

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid data.

2. The mobile communication terminal according to claim 1, wherein

said control unit (4) determines the invalid data based on information received from the base station, and stops the processing of said data.

3. The mobile communication terminal according to claim 2, wherein

said detector (5, 6, 7) includes:

a slot timing detector (5) detecting slot timing from the signals received by said receiver (2),

a code group detector (6) detecting a code group based on the slot timing detected by said slot timing detector (5), and

a code detector (7) detecting a code based on the slot timing detected by said slot timing detector (5).

4. The mobile communication terminal according to claim 3, wherein

said control unit (4) stops the processing of received data when the code group detected by said code group detector (6) is not a predetermined

code.

5. The mobile communication terminal according to claim 4, wherein

said code group detector (6) includes:

a plurality of code generators (15-1 - 15-N), each of said code generators (15-1 - 15-M) generating a different code group,

a dummy code generator (15-(M+1) - 15-N) generating a dummy code different from the code groups generated by said plurality of code generators (15-1 - 15-M),

a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 - 16-N) calculating correlation between the signal received by said receiver (2) and the code generated by the corresponding code generator (15-1 - 15-N), and

a determining unit (18) determining invalidity of the data based on the calculation result of said plurality of correlators (16-1 - 16-N).

6. The mobile communication terminal according to claim 3, wherein

said control unit (4) stops the processing of the received data if the code detector (7) detects a code other than the predetermined code.

7. The mobile communication terminal according to claim 6, wherein

said code detector (7) includes:

a plurality of code generators (19-1 - 19-N), each of said code generators (19-1 - 19-M) generating a different code,

a dummy code generator (19-(M+1) - 19-N) generating a dummy code different from the codes generated by said plurality of code generators (19-1 - 19-M),

a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N),

and

a determining unit (22) determining invalidity of the data based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) dividing a slot into a plurality of search ranges, deleting multipath in said search range and successively decoding the received data by said decoder (9).

9. The mobile communication terminal according to claim 8, wherein

said control unit (4) stops the decode processing if the received data in said search range is invalid data.

10. A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

demodulating the received signals with said detected spread codes;

decoding said demodulated data; and

controlling cell search process, and stopping signal processing of the cell search if said received data is invalid.

11. The communication method according to claim 10, wherein

said step of stopping the signal processing of the cell search includes the step of determining invalid data based on information received from the base station, and stopping the processing of the data.

12. The communication method according to claim 11, wherein said step of detecting the spread codes includes the steps of:

detecting slot timing from said received signals,

detecting a code group based on said detected slot timing, and

detecting a code based on said detected slot timing.

13. The communication method according to claim 12, wherein said step of stopping the processing of said received data includes the step of stopping the signal processing of the cell search if the code group received from the base station is not a predetermined code.

14. The communication method according to claim 13, wherein said step of stopping the signal processing of the cell search includes the steps of:

generating a plurality of different code groups,

generating a dummy code different from said plurality of generated code groups,

calculating correlations of said received signals with respect to said plurality of generated code and the dummy code, and

determining invalidity of the data based on a result of said calculation.

15. The communication method according to claim 12, wherein said step of stopping the processing of said received data includes the step of stopping the processing of the received data if the code received from the base station is not a predetermined code.

16. The communication method according to claim 15, wherein said step of stopping the processing of said received data includes the steps of:

generating a plurality of different codes,

generating a dummy code different from said generated code,

calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and

determining invalidity of the data based on a result of said calculation.

17. A communication method comprising the steps of:

receiving a radio wave from base stations;

detecting spread codes from said received signals;

deleting multipath of the code already detected;

successively demodulating the received data subjected to the deletion of the multipath with said detected spread codes; and

decoding said demodulated data.

18. The communication method according to claim 17, wherein said decoding processing is not performed in said step of deleting the multipath if the newly detected code is the multipath.

09/936294

FIG.1

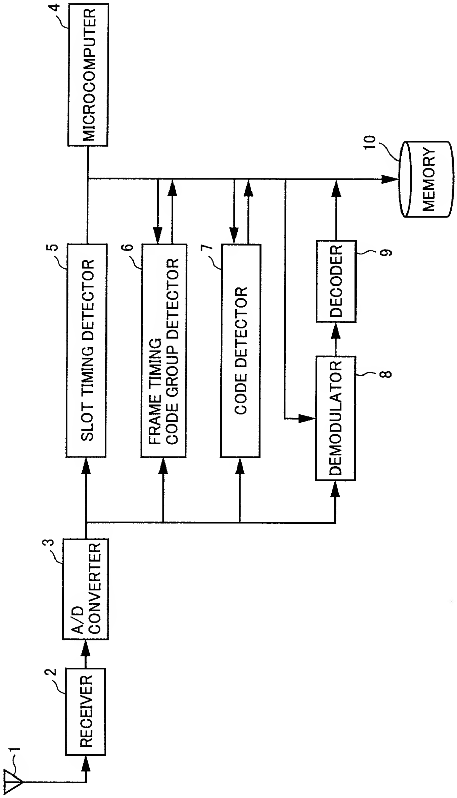


FIG.2

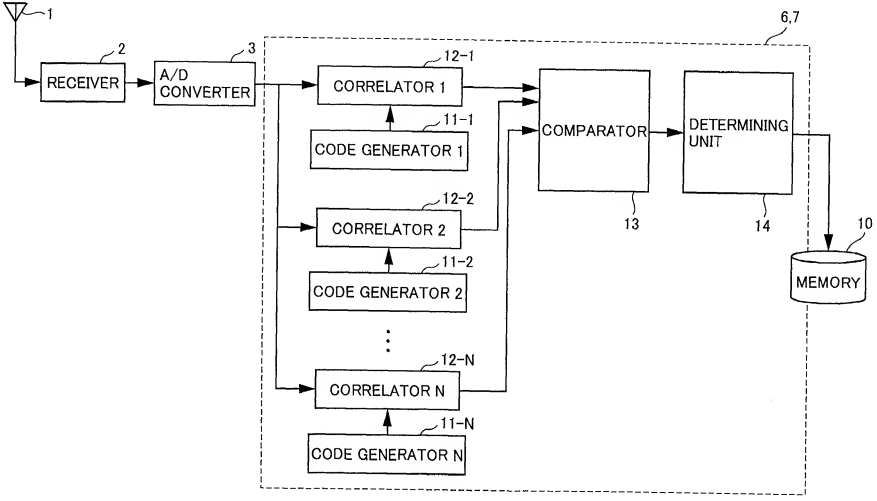


FIG.3

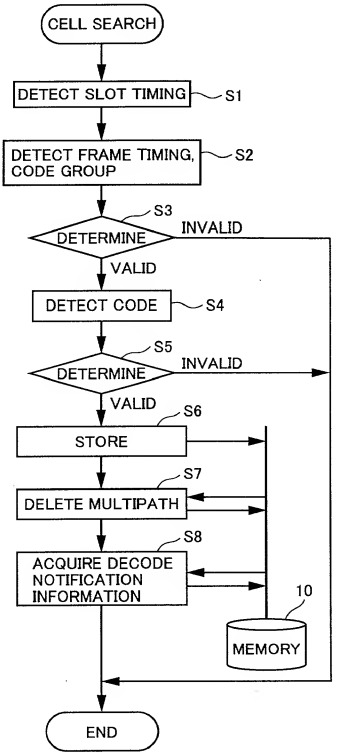


FIG.4

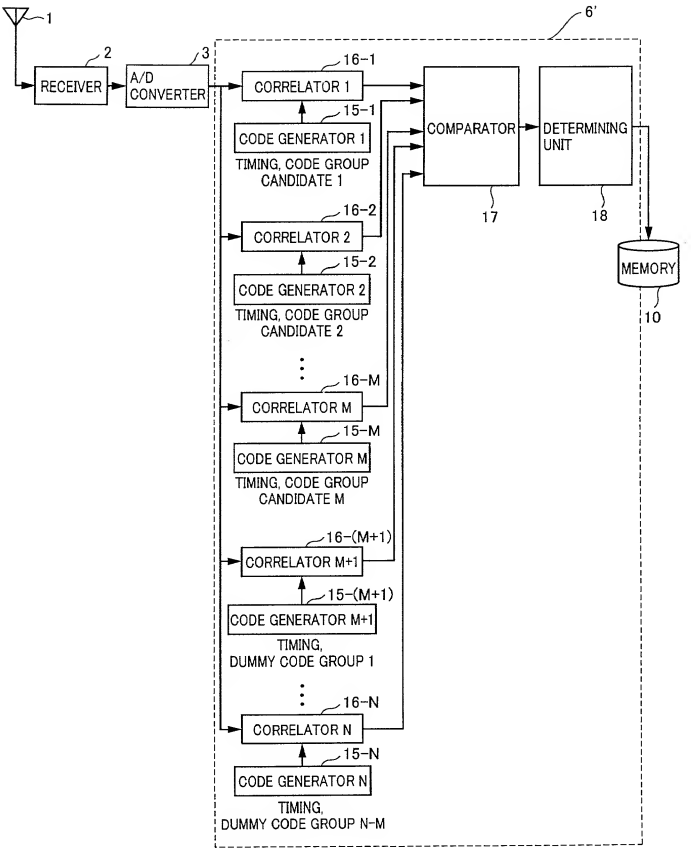

1
6'
2
RECEIVER
3
A/D CONVERTER
16-1
CORRELATOR 1
15-1
CODE GENERATOR 1
TIMING, CODE GROUP CANDIDATE 1
16-2
CORRELATOR 2
15-2
CODE GENERATOR 2
TIMING, CODE GROUP CANDIDATE 2
16-M
CORRELATOR M
15-M
CODE GENERATOR M
TIMING, CODE GROUP CANDIDATE M
16-(M+1)
CORRELATOR M+1
15-(M+1)
CODE GENERATOR M+1
TIMING, DUMMY CODE GROUP 1
16-N
CORRELATOR N
15-N
CODE GENERATOR N
TIMING, DUMMY CODE GROUP N-M
COMPARATOR
17
DETERMINING UNIT
18
MEMORY
10

FIG.5

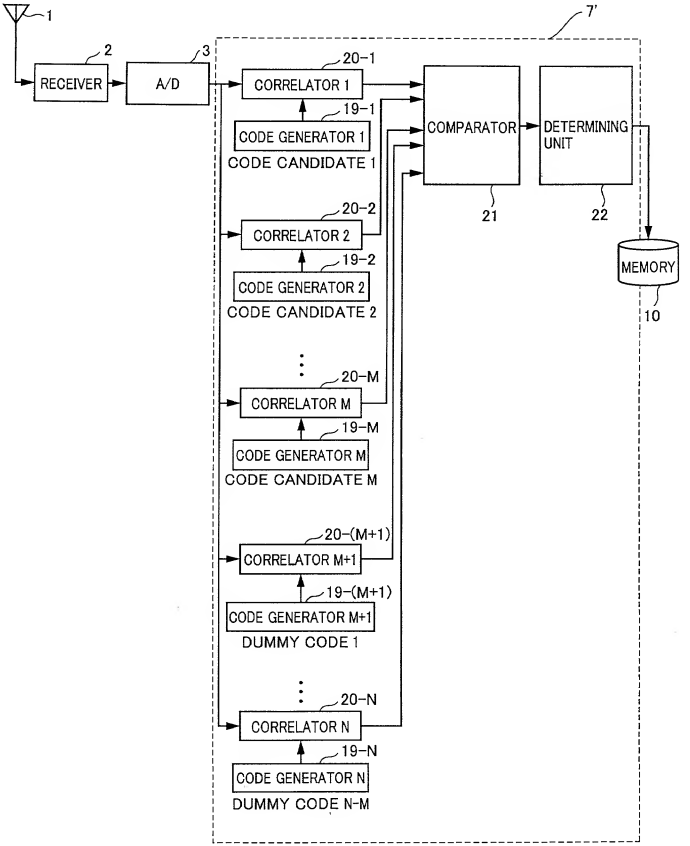

1
2
RECEIVER
3
A/D
7'
20-1
CORRELATOR 1
19-1
CODE GENERATOR 1
CODE CANDIDATE 1
20-2
CORRELATOR 2
19-2
CODE GENERATOR 2
CODE CANDIDATE 2
20-M
CORRELATOR M
19-M
CODE GENERATOR M
CODE CANDIDATE M
20-(M+1)
CORRELATOR M+1
19-(M+1)
CODE GENERATOR M+1
DUMMY CODE 1
20-N
CORRELATOR N
19-N
CODE GENERATOR N
DUMMY CODE N-M
COMPARATOR
21
DETERMINING UNIT
22
MEMORY
10

FIG.6

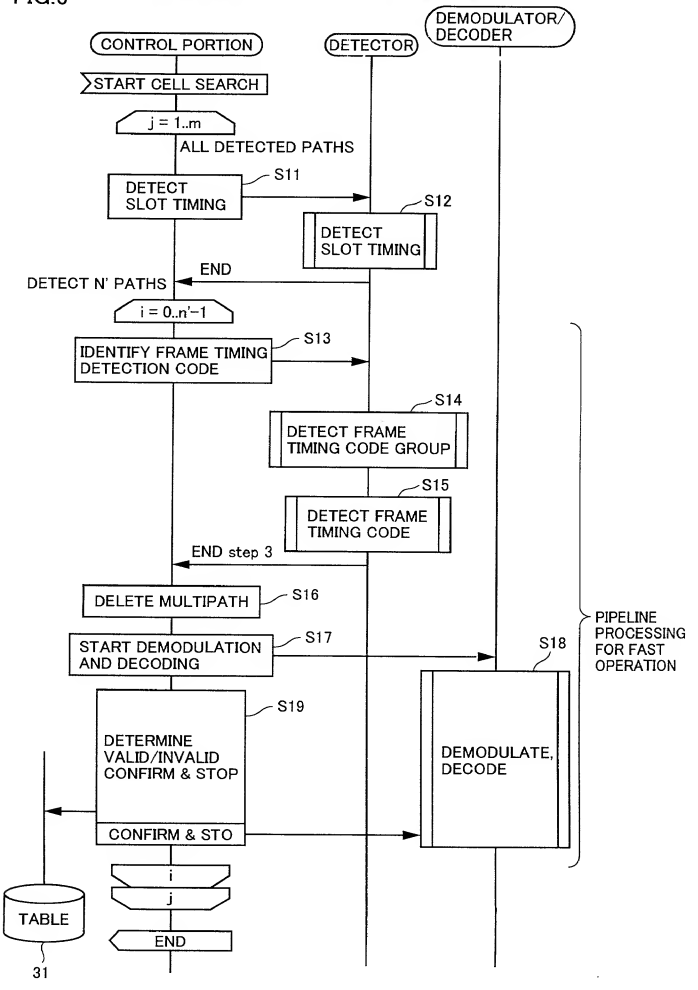

CONTROL PORTION
DETECTOR
DEMODULATOR/ DECODER
START CELL SEARCH
j = 1..m
ALL DETECTED PATHS
DETECT SLOT TIMING
S11
DETECT SLOT TIMING
S12
END
DETECT N' PATHS
i = 0..n'−1
IDENTIFY FRAME TIMING DETECTION CODE
S13
DETECT FRAME TIMING CODE GROUP
S14
DETECT FRAME TIMING CODE
S15
END step 3
DELETE MULTIPATH
S16
START DEMODULATION AND DECODING
S17
S18
PIPELINE PROCESSING FOR FAST OPERATION
DETERMINE VALID/INVALID CONFIRM & STOP
S19
DEMODULATE, DECODE
CONFIRM & STO
i
j
TABLE
END
31

FIG.7

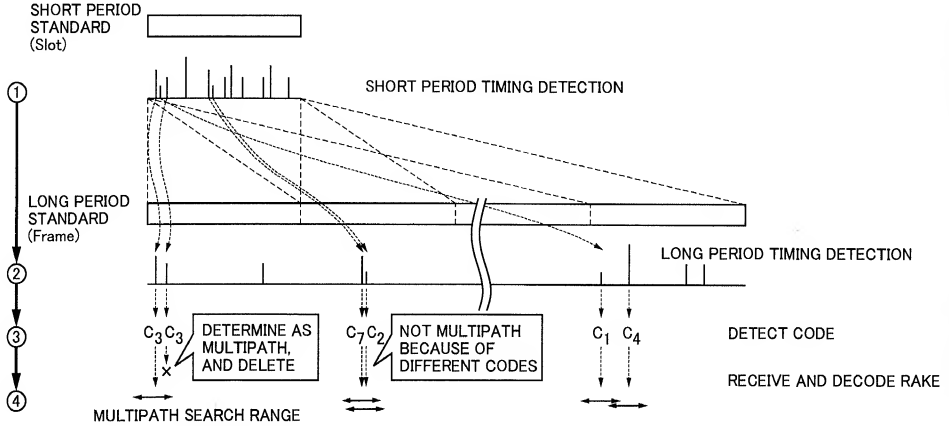


FIG.8 PRIOR ART

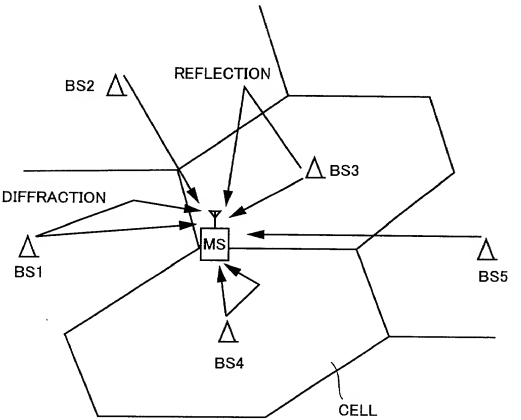
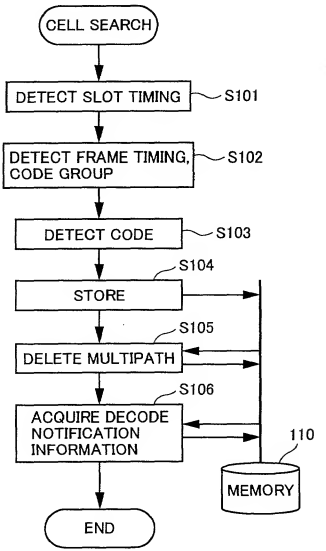


FIG.9 PRIOR ART



Declaration and Power of Attorney For Patent Application

特許出願宣言書

Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり宣言する：

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

My residence, post office address and citizenship are as stated below next to my name,

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である（一人の氏名のみが下欄に記載されている場合）か、もしくは本来の、最初にして共同の発明者である（複数の氏名が下欄に記載されている場合）と信じ、

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MOBILE COMMUNICATION TERMINAL AND COMMUNICATION METHOD ✓

その明細書を
（該当する方に印を付す）

the specification of which
(check one)

☐ ここに添付する。

☐ is attached hereto.

☐ _____ 日に出願番号

☒ was filed on September 12, 2001 ✓ as Application Serial No. _____

第 _____ 号として提出し、

and was amended on September 12, 2001 ✓ (if applicable)

_____ 日に補正した。
（該当する場合）

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討し、理解したことを陳述する。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37部第１章第56条（ａ）項に従い、本願の審査に所要の情報を開示すべき義務を有することを認める。

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Japanese Language Declaration

私は、合衆国法典第35部第119 条にもとづく下記の外国特許出願または発明者証出願の外国優先権利益を主張し、さらに優先権の主張に係わる基礎出願の出願日前の出願日を有する外国特許出願または発明者証出願を以下に明記する：

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign applications
先の外国出願

(Number) (番　号)	(Country) (国　名)	(Day/Month/Year Filed) (出願の年月日)	Priority claimed 優先権の主張 ☐ Yes あり	☐ No なし
(Number) (番　号)	(Country) (国　名)	(Day/Month/Year Filed) (出願の年月日)	☐ Yes あり	☐ No なし
(Number) (番　号)	(Country) (国　名)	(Day/Month/Year Filed) (出願の年月日)	☐ Yes あり	☐ No なし

私は、合衆国法典第35部第120 条にもとづく下記の合衆国特許出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第35部第112 条第１項に規定の態様で先の合衆国出願に開示されていない限度において、先の出願の出願日と本願の国内出願日またはＰＣＴ国際出願日の間に公表された連邦規則法典第37部第１章第56条（ａ）項に記載の所要の情報を開示すべき義務を有することを認める：

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.) (出願番号)	(Filing Date) (出願日)	(現　況) (特許済み、係属中、放棄済み)	(Status) (patented, pending, abandoned)
(Application Serial No.) (出願番号)	(Filing Date) (出願日)	(現　況) (特許済み、係属中、放棄済み)	(Status) (patented, pending, abandoned)

私は、ここに自己の知識にもとづいて行った陳述がすべて真実であり、自己の有する情報および信ずるところに従って行った陳述が真実であると信じ、さらに故意に虚偽の陳述等を行った場合、合衆国法典第18部第1001条により、罰金もしくは禁錮に処せられるか、またはこれらの刑が併科され、またかかる故意による虚偽の陳述が本願ないし本願に対して付与される特許の有効性を損うことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

委任状：私は、下記発明者として、以下の代理人をここに選任し、本願の手続を遂行すること並びにこれに関する一切の行為を特許商標庁に対して行うことを委任する。
（代理人氏名および登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (*list name and registration number*)

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Barbara G. Ernst, Reg. No. 30,377
George R. Repper, Reg. No. 31,414
Bart G. Newland, Reg. No. 31,282
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Joseph A. Hynds, Reg. No. 34,627
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（第六またはそれ以降の共同発明者に対しても同様な情報および署名を提供すること。）

(Supply similar information and signature for third and subsequent joint inventors.)